```
!nvcc --version
```

```
nvcc: NVIDIA (R) Cuda compiler driver
Copyright (c) 2005-2022 NVIDIA Corporation
Built on Wed_Sep_21_10:33:58_PDT_2022
Cuda compilation tools, release 11.8, V11.8.89
Build cuda_11.8.r11.8/compiler.31833905_0
```

```
!pip install git+https://github.com/andreinechaev/nvcc4jupyter.git
```

```
Collecting git+https://github.com/andreinechaev/nvcc4jupyter.git
  Cloning https://github.com/andreinechaev/nvcc4jupyter.git to /tmp/pip-req-build-6bj1ehhm
  Running command git clone --filter=blob:none --quiet https://github.com/andreinechaev/nvcc4jupyter.git /tmp/pip-req-build-6bj1ehhm
  Resolved https://github.com/andreinechaev/nvcc4jupyter.git to commit 0a71d56e5dce3ff1f0dd2c47c29367629262f527
  Preparing metadata (setup.py) ... done
Building wheels for collected packages: NVCCPlugin
  Building wheel for NVCCPlugin (setup.py) ... done
  Created wheel for NVCCPlugin: filename=NVCCPlugin-0.0.2-py3-none-any.whl size=4295 sha256=18df8bc776ffcf78c62cd1aa7c2f254a9646f54cc6a
  Stored in directory: /tmp/pip-ephem-wheel-cache-4ck5k4c6/wheels/a8/b9/18/23f8ef71ceb0f63297dd1903aedd067e6243a68ea756d6feea
Successfully built NVCCPlugin
Installing collected packages: NVCCPlugin
Successfully installed NVCCPlugin-0.0.2
```

```
!pip install pycuda
```

```
Collecting pycuda
  Downloading pycuda-2022.2.2.tar.gz (1.7 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.7/1.7 MB 23.5 MB/s eta 0:00:00
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Preparing metadata (pyproject.toml) ... done
Collecting pytools>=2011.2 (from pycuda)
  Downloading pytools-2023.1.1-py2.py3-none-any.whl (70 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 70.6/70.6 kB 10.4 MB/s eta 0:00:00
Requirement already satisfied: appdirs>=1.4.0 in /usr/local/lib/python3.10/dist-packages (from pycuda) (1.4.4)
Collecting mako (from pycuda)
  Downloading Mako-1.2.4-py3-none-any.whl (78 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 78.7/78.7 kB 11.5 MB/s eta 0:00:00
Requirement already satisfied: platformdirs>=2.2.0 in /usr/local/lib/python3.10/dist-packages (from pytools>=2011.2->pycuda) (3.11.0)
Requirement already satisfied: typing-extensions>=4.0 in /usr/local/lib/python3.10/dist-packages (from pytools>=2011.2->pycuda) (4.5.0)
Requirement already satisfied: MarkupSafe>=0.9.2 in /usr/local/lib/python3.10/dist-packages (from mako->pycuda) (2.1.3)
Building wheels for collected packages: pycuda
  Building wheel for pycuda (pyproject.toml) ... done
  Created wheel for pycuda: filename=pycuda-2022.2.2-cp310-cp310-linux_x86_64.whl size=661265 sha256=d522dc600b9ffbb8c54d678a815fcee481
  Stored in directory: /root/.cache/pip/wheels/1d/7b/06/82a395a243fce00035dea9914d92bbef0013401497d849f8bc
Successfully built pycuda
Installing collected packages: pytools, mako, pycuda
Successfully installed mako-1.2.4 pycuda-2022.2.2 pytools-2023.1.1
```

```
import pycuda.driver as drv
import pycuda.autoinit
drv.init()
print("%d device(s) found." % drv.Device.count())
```

```
1 device(s) found.
```

Ejercicio 1

```
!nvcc /content/hello.cu -o "/content/hello" -arch=sm_75
```

```
/content/hello.cu: In function ‘int main()’:
/content/hello.cu:22:22: warning: ‘cudaError_t cudaThreadSynchronize()’ is deprecated [-Wdeprecated-declarations]
   22 |   cudaThreadSynchronize(); //deprecated
      |   ~~~~~~~~~~~~~~~~~~~~^~
/usr/local/cuda/bin/../targets/x86_64-linux/include/cuda_runtime_api.h:1052:46: note: declared here
 1052 | extern __CUDA_DEPRECATED __host__ cudaError_t CUDARTAPI cudaThreadSynchronize(void);
      |                                              ^~~~~~~~~~~~~~~~~~~~
```

```
!chmod 755 /content/hello
!/content/hello
```

```
Hello world
Hello world
```

```
Hello world
Hello world
Hello world
Hello world
Hello world
Hello world
Hello world
Hello world
```

3. Modifique el programa para correr 2 bloques de 1024 hilos. Modificarlo también para que imprima su nombre y carnet. Busque en el despliegue de consola el mensaje del último hilo de la serie (1023).

```
!nvcc /content/hello_1024.cu -o "/content/hello_1024" -arch=sm_75
```

```
/content/hello_1024.cu: In function ‘int main()’:
/content/hello_1024.cu:26:22: warning: ‘cudaError_t cudaThreadSynchronize()’ is deprecated [-Wdeprecated-declarations]
   26 |     cudaThreadSynchronize(); // deprecated
      |     ~~~~~~~~~~~~~~~~~~^~
/usr/local/cuda/bin/../targets/x86_64-linux/include/cuda_runtime_api.h:1052:46: note: declared here
 1052 | extern __CUDA_DEPRECATED __host__ cudaError_t CUDARTAPI cudaThreadSynchronize(void);
      |                                              ^~~~~~~~~~~~~~~~~~~~~
```

```
!chmod 755 /content/hello_1024
!/content/hello_1024
```

```
Hello world from thread 1115 in block 1
Hello world from thread 1116 in block 1
Hello world from thread 1117 in block 1
```

El programa crea 2 bloques de 1024 hilos cada uno para un total de 2048 hilos. Como resultado podemos ver que cada hilo imprime "Hello world" junto con su número de hilo y el número de bloque al que pertenece. El ultimo hilo imprime ademas mi nombre y mi carnet

4. Busque en el sitio de Nvidia el Compute Capability de la tarjeta que poseen las máquinas del Laboratorio (o de la computadora que está utilizando). Escriba acá el valor de CC y busque la tabla resumen con las características técnicas del CC

```
!nvidia-smi
```

```
Fri Nov  3 22:48:36 2023
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 525.105.17   Driver Version: 525.105.17   CUDA Version: 12.0     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Tesla T4            Off  | 00000000:00:04.0 Off |                    0 |
| N/A   64C    P0    33W /  70W |    103MiB / 15360MiB |      4%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
+-----------------------------------------------------------------------------+
```

CC DE Tesla T4: 7.5

Modifique el programa para correr 1 bloque de 2048 hilos.

```
!nvcc /content/hello_2048.cu -o "/content/hello_2048" -arch=sm_75
```

```
/content/hello_2048.cu: In function ‘int main()’:
/content/hello_2048.cu:26:22: warning: ‘cudaError_t cudaThreadSynchronize()’ is deprecated [-Wdeprecated-declarations]
   26 |     cudaThreadSynchronize(); // deprecated
      |     ~~~~~~~~~~~~~~~~~~^~
/usr/local/cuda/bin/../targets/x86_64-linux/include/cuda_runtime_api.h:1052:46: note: declared here
 1052 | extern __CUDA_DEPRECATED __host__ cudaError_t CUDARTAPI cudaThreadSynchronize(void);
      |                                              ^~~~~~~~~~~~~~~~~~~~~
```

```
!chmod 755 /content/hello_2048
!/content/hello_2048
```

Como estamos intentando ejecutar 2048 hilos en un solo bloque, es más de lo que la GPU puede manejar entonces no se puede completar la tarea debido a la limitación de recursos, y por eso no se muestra ningún resultado como output.

Busque en la tabla de CC los siguientes datos de la GPU que está utilizando: (TESLA T4)

- Warp size: 32
- Maximum number of threads per block: 1024
- Maximum dimensionality of a grid of thread blocks: 3
- Maximum size per grid dimension: 2^31 - 1 (aproximadamente 2.1 mil millones)
- Maximum dimensionality of a thread block: 3
- Maximum size per block dimension: 1024

Ejercicio 2

1. Descargue, compile y ejecute hello2.cu. Observe la relación de la configuración de la llamada al kernel con la geometría de los hilos y el resultado. Escriba la respuesta a los dos enunciados:

```
!nvcc /content/hello2.cu -o "/content/hello2" -arch=sm_75
```

```
/content/hello2.cu: In function ‘int main()’:
/content/hello2.cu:38:22: warning: ‘cudaError_t cudaThreadSynchronize()’ is deprecated [-Wdeprecated-declarations]
   38 |   cudaThreadSynchronize ();
      |   ~~~~~~~~~~~~~~~~~~~^~
/usr/local/cuda/bin/../targets/x86_64-linux/include/cuda_runtime_api.h:1052:46: note: declared here
 1052 | extern __CUDA_DEPRECATED __host__ cudaError_t CUDARTAPI cudaThreadSynchronize(void);
      |                                              ^~~~~~~~~~~~~~~~~~~~~
```

```
!chmod 755 /content/hello2
!/content/hello2
```

```
Hello world from 82
Hello world from 83
Hello world from 84
Hello world from 85
Hello world from 86
Hello world from 87
Hello world from 88
Hello world from 89
Hello world from 230
Hello world from 231
Hello world from 232
Hello world from 233
Hello world from 234
Hello world from 235
Hello world from 236
Hello world from 237
Hello world from 238
Hello world from 239
Hello world from 140
Hello world from 141
Hello world from 142
Hello world from 143
Hello world from 144
Hello world from 145
Hello world from 146
Hello world from 147
Hello world from 148
Hello world from 149
Hello world from 40
Hello world from 41
Hello world from 42
Hello world from 43
Hello world from 44
Hello world from 45
Hello world from 46
Hello world from 47
Hello world from 48
Hello world from 49
Hello world from 190
Hello world from 191
Hello world from 192
Hello world from 193
Hello world from 194
Hello world from 195
Hello world from 196
Hello world from 197
Hello world from 198
Hello world from 199
Hello world from 90
Hello world from 91
Hello world from 92
Hello world from 93
Hello world from 94
Hello world from 95
Hello world from 96
Hello world from 97
Hello world from 98
Hello world from 99
```

- Máximo ID de los hilos: 239
- Ejecución de los hilos en orden: No hay un orden especifico

2. Observe que la fórmula genérica para cálculo del ID global está en los comentarios. Modifique el programa para que imprima también su nombre y carné. Luego, realice la siguiente modificación al programa (al inicio del main) y use la fórmula genérica para derivar el nuevo cálculo de ID:

```
!nvcc /content/hello2_form.cu -o "/content/hello2_form" -arch=sm_75
```

```
!chmod 755 /content/hello2_form
!/content/hello2_form
```

```
    Hello world from thread 2438: - Cristian Aguirre 20231
    Hello world from thread 2439: - Cristian Aguirre 20231
    Hello world from thread 2440: - Cristian Aguirre 20231
    Hello world from thread 2441: - Cristian Aguirre 20231
    Hello world from thread 2442: - Cristian Aguirre 20231
    Hello world from thread 2443: - Cristian Aguirre 20231
    Hello world from thread 2444: - Cristian Aguirre 20231
    Hello world from thread 2445: - Cristian Aguirre 20231
    Hello world from thread 2446: - Cristian Aguirre 20231
    Hello world from thread 2447: - Cristian Aguirre 20231
    Hello world from thread 2448: - Cristian Aguirre 20231
    Hello world from thread 2449: - Cristian Aguirre 20231
    Hello world from thread 2450: - Cristian Aguirre 20231
    Hello world from thread 2451: - Cristian Aguirre 20231
    Hello world from thread 2452: - Cristian Aguirre 20231
    Hello world from thread 2453: - Cristian Aguirre 20231
    Hello world from thread 2454: - Cristian Aguirre 20231
    Hello world from thread 2455: - Cristian Aguirre 20231
    Hello world from thread 2456: - Cristian Aguirre 20231
    Hello world from thread 2457: - Cristian Aguirre 20231
    Hello world from thread 2458: - Cristian Aguirre 20231
    Hello world from thread 2459: - Cristian Aguirre 20231
    Hello world from thread 2460: - Cristian Aguirre 20231
    Hello world from thread 2461: - Cristian Aguirre 20231
    Hello world from thread 2462: - Cristian Aguirre 20231
    Hello world from thread 2463: - Cristian Aguirre 20231
    Hello world from thread 3040: - Cristian Aguirre 20231
    Hello world from thread 3041: - Cristian Aguirre 20231
    Hello world from thread 3042: - Cristian Aguirre 20231
    Hello world from thread 3043: - Cristian Aguirre 20231
    Hello world from thread 3044: - Cristian Aguirre 20231
    Hello world from thread 3045: - Cristian Aguirre 20231
    Hello world from thread 3046: - Cristian Aguirre 20231
    Hello world from thread 3047: - Cristian Aguirre 20231
    Hello world from thread 3048: - Cristian Aguirre 20231
    Hello world from thread 3049: - Cristian Aguirre 20231
    Hello world from thread 3050: - Cristian Aguirre 20231
    Hello world from thread 3051: - Cristian Aguirre 20231
    Hello world from thread 3052: - Cristian Aguirre 20231
    Hello world from thread 3053: - Cristian Aguirre 20231
    Hello world from thread 3054: - Cristian Aguirre 20231
    Hello world from thread 3055: - Cristian Aguirre 20231
    Hello world from thread 3056: - Cristian Aguirre 20231
    Hello world from thread 3057: - Cristian Aguirre 20231
    Hello world from thread 3058: - Cristian Aguirre 20231
    Hello world from thread 3059: - Cristian Aguirre 20231
    Hello world from thread 3060: - Cristian Aguirre 20231
    Hello world from thread 3061: - Cristian Aguirre 20231
    Hello world from thread 3062: - Cristian Aguirre 20231
    Hello world from thread 3063: - Cristian Aguirre 20231
    Hello world from thread 3064: - Cristian Aguirre 20231
    Hello world from thread 3065: - Cristian Aguirre 20231
    Hello world from thread 3066: - Cristian Aguirre 20231
    Hello world from thread 3067: - Cristian Aguirre 20231
    Hello world from thread 3068: - Cristian Aguirre 20231
    Hello world from thread 3069: - Cristian Aguirre 20231
    Hello world from thread 3070: - Cristian Aguirre 20231
    Hello world from thread 3071: - Cristian Aguirre 20231
```

La GPU Tesla T4 con Compute Capability 7.5 tiene las siguientes dimensiones máximas para hilos por bloque y bloques en x, y, y z:

- Máximo de hilos por bloque en x, y, y z: 1024
- Máximo de bloques en x, y, y z: 2147483647 (aproximadamente 2.1 mil millones)

```
!nvcc /content/ejercicio3.cu -o "/content/ejercicio3" -arch=sm_75
```

```
!chmod 755 /content/ejercicio3
```

```
!/content/ejercicio3
```

```
Hello world the maximum global ID 100351: - Cristian Aguirre 20231
```